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Mass segregation in the young open cluster NGC 2547

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ABSTRACT
We present a study of mass segregation of the young (20–35 Myr isochronal age), open cluster NGC 2547. We find good evidence that mass segregation exists in NGC 2547 down to 3M$_\odot$, and weak evidence for mass segregation down to 1M$_\odot$. Theoretical models of an initially unsegregated model of NGC 2547 using the NBODY2 code show weaker mass segregation, implying that at least some of the observed mass segregation has a primordial origin. We also report the discovery of three possible escaped cluster members, which share the proper motion and colours of the cluster, but lie nearly a degree from the cluster centre.

Key words: open clusters and associations: individual: NGC 2547 - stars: formation - stars: pre-main-sequence

1 INTRODUCTION

Most stars do not form in isolation, but in rich clusters of stars, with sizes ranging from several tens of stars to clusters containing several thousand stars. Observations of young clusters typically find that the most massive stars are located near the cluster centre (Hillenbrand & Hartmann 1998; Raboud 1999). What is not certain is whether this reflects the initial conditions of star formation, or the process of dynamical evolution.

Dynamical evolution in a stellar cluster drives the system towards equipartition, the natural result of this being that the lower-mass stars attain higher velocities and hence occupy larger orbits around the cluster centre. In turn, the higher mass stars will sink towards the cluster centre. Bonnell & Davies (1998) showed that the timescale for significant dynamical mass segregation to occur is comparable with the relaxation time for a cluster,

$$\tau_r \approx \frac{N}{8 \ln N} \tau_{cr}, \tag{1}$$

where N is the number of stars within the cluster and τ_{cr} is the crossing time. Another measure of the clusters relaxation timescale is its half-mass, or median timescale (de Grijs et al. 2002),

$$\tau_{r,h} = \left(8.92 \times 10^5\right) \frac{M_{tot}^{1/2}}{\langle m \rangle} \frac{R_h^{3/2}}{\log_{10}\left(0.4 M_{tot}/\langle m \rangle\right)} \,\mathrm{yr}, \tag{2}$$

where R_h is the half-mass radius in parsecs, $\langle m \rangle$ is the mean stellar mass, and M_{tot} is the total cluster mass, both expressed in solar units. This equation represents the relaxation timescale for the inner half of the cluster mass, for stars with characteristic velocity dispersions and average masses.

In practice the situation is complicated because mass segregation is a local, not a global effect. The mass segregation timescale is smaller for the higher mass stars (e.g. Kontizas et al. 1998), is smaller in the cluster core than in the outer regions (e.g Hillenbrand & Hartmann 1998) and is larger for stars with higher velocity dispersions. Even the concept of a local relaxation time is approximate as mass segregation is an ongoing process. For example, the relaxation time for high mass stars is a decreasing function of time, as the orbits of the high mass stars evolve closer to the cluster core with time. Complicating matters even further, the time-scale for a cluster to lose all traces of its initial conditions depends on the number of stars (Bonnell & Davies 1998) the frequency of binary stars and the slope of the mass function.

Bearing this is mind, it is not surprising that it is often difficult to establish how much dynamical evolution a cluster should have undergone. Determining this is important because the *initial* distribution of mass within the cluster may not be uniform, due to the details of the star formation process. Although in the classic picture of star formation (Shu et al. 1987) mass segregation does not occur, there are competing models in which the most massive stars are expected to form near the cluster centre. One such model pro-

poses that high mass stars are formed by mergers of lower mass protostellar clumps (e.g. Bonnell et al. 1997) - implying that high mass stars form in the centre of the cluster, where the density of these clumps is highest. Alternatively, it has been suggested that protostars are competing for the accretion of gas (Bonnell et al. 2001) - implying that the higher mass stars form in the centre of the cluster because that is where the gas density is highest.

Studies of mass segregation in very young open clusters seem to suggest that primordial mass segregation is a reality; mass segregation is already present in the clusters NGC 2024, NGC 2071 and Mon R2 (Lada & Lada 1991; Hillenbrand & Hartmann 1998), despite the fact that these clusters are still embedded in their parental cloud and are not even a crossing time old. Both Hillenbrand & Hartmann (1998) and Bonnell & Davies (1998) argue convincingly that the mass segregation observed in the Orion Nebular Cloud is, at least partly, due to primordial mass segregation.

Observations of older clusters usually reveal the mass segregation expected of a dynamically relaxed cluster. Mass segregation has, for example, been observed in the Pleiades, NGC 2516, Praesepe and M67 (Raboud & Mermilliod 1998; Mathieu & Latham 1986; Jeffries et al. 2001), with ages of 100, 150, 800 and 5000 Myr respectively. However, Raboud & Mermilliod (1998) found the degree of mass segregation for stars between 1.5 and 2.3 $M_{\odot}$ is less pronounced in Praesepe than in the Pleiades, which is unexpected given their ages.

Here we present a study of mass segregation in the young open cluster NGC 2547. At an age of 20–35 Myr this cluster represents an intermediary between very young open clusters like the Orion Nebular Cluster, and older clusters like the Pleiades. Studies of mass segregation in clusters of this intermediate age are useful because mass segregation should just be starting to appear. Furthermore, it has been suggested that a subset of clusters at this age should show no mass segregation, due to violent relaxation following the loss of the highest mass stars through supernovae (Raboud & Mermilliod 1998). In section 2, we describe the catalogue used to select cluster members. Section 3 outlines the process of member selection, whilst in section 5 we determine the degree of mass segregation present in the cluster, and compare this to expectations from theoretical arguments.

1.1 NGC 2547

The open cluster NGC2547 (= C0809-491) lies at Galactic co-ordinates l = 264.45° b = −8.53° (α = 08 10 25.7, δ = -49 10 03; J2000). Clariá (1982) derived a reddening for the cluster of $E(B-V) = 0.06$. Naylor et al. (2002) revisited the dataset of Jeffries & Tolley (1998), improving their photometry by using optimal photometry techniques. They determined an age of 20–35 Myr and an intrinsic distance modulus of 8.00–8.15 magnitudes (400–425 parsecs). They estimated the cluster mass at 370 M$_{\odot}$. Hence, NGC 2547 is much less massive than previously well studied open clusters like the Pleiades and NGC 2516 and less massive than the well studied Orion Nebular Cluster (ONC).

NGC 2547 is a cluster of intermediate age, although the exact age remains uncertain. Whilst isochronal fitting to colour magnitude diagrams suggests an age of 20–35 Myr (Naylor et al. 2002), the location of the lithium depletion boundary suggests that the age is between 35 and 54 Myr (Olivera et al. 2003). For the purposes of this paper we adopt the isochronal age, although our results are not affected if the older age is assumed.

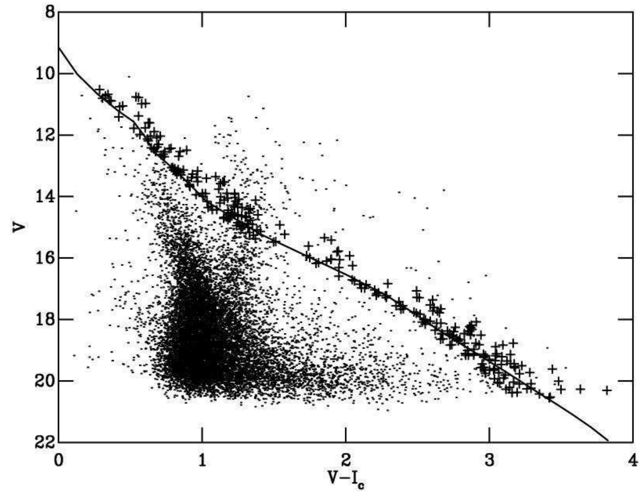

Figure 1. V vs. $V-I_c$ for NGC 2547. The solid line is the best fitting D'Antona & Mazitelli isochrone from Naylor et al. (2002) and crosses represent candidate members selected in section 3. Sources with a signal-to-noise ratio worse than 10 have been omitted.

2 THE CATALOGUE

The analysis which follows in sections 3 and 4 is based upon the wide photometric catalogue of Naylor et al. (2002). The catalogue is the result of a BVI_c survey of NGC 2547, centred on α = 08 10 17.4, δ = -48 57 00. The survey consists of 9 fields covering a total of 34×34 arcmins. The survey contains no information for the brightest objects, as stars brighter than $V \simeq 8$ saturated in the exposure times used. Naylor et al. (2002) obtained this information from the photometry of Clariá (1982). As a consequence of this, the brightest stars only have V magnitudes and $B-V$ colours. The catalogue in which the photometry for the brightest stars has been added is referred to as *enhanced*. Colour magnitude diagrams for the enhanced catalogue are shown in figures 1 and 2.

2.1 Completeness

The catalogue of Naylor et al. (2002) has been produced using optimal photometry techniques, detailed within that paper. These techniques have the advantage of producing colour-magnitude diagrams with well understood completeness properties. Naylor et al. (2002) measure the completeness of our catalogue in the regions where it overlaps their, deeper, catalogue, and find that it is essentially complete, down to a V magnitude of 20.5. Also, the completeness drops sharply from 90% to 10% in half a magnitude. In this paper we are interested in the completeness of our catalogue as a function of position. We assessed this by injecting a simulated sequence of pre-main sequence stars into the data and

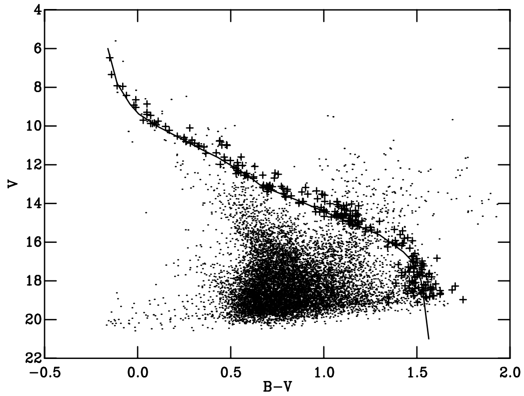

Figure 2. B vs. $B-V$ for the enhanced catalogue. The solid line is the best fitting D'Antona & Mazitelli isochrone from Naylor et al. (2002). The isochrone has been extended above V=8 using the models of Schaller et al. (1992). Crosses represent candidate members selected in section 3. Sources with a signal-to-noise ratio worse than 10 have been omitted.

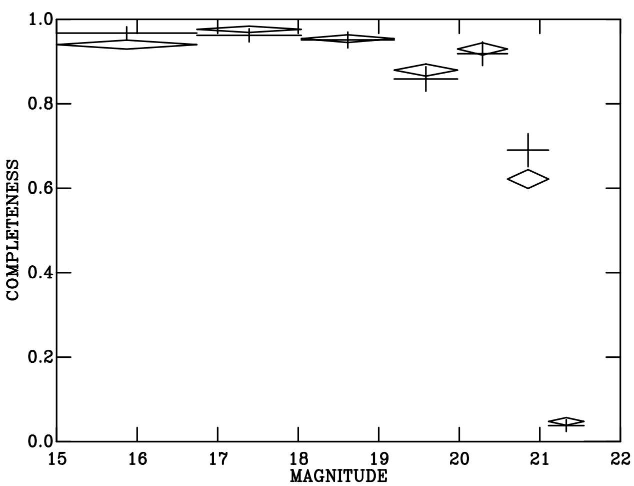

Figure 3. The completeness function for the catalogue. The completeness function inside a radius of 10 arcmins is marked by error bars, whilst the completeness function outside a radius of 10 arcmins is shown using error boxes. The completeness functions are remarkably similar, showing that the completeness of the wide catalogue does not vary between the inner and outer regions.

determining what fraction are selected as cluster members in our final catalogue (see Naylor et al. 2002, for details). Figure 3 shows that the completeness properties do not vary between the inner and outer regions, and that the wide catalogue is complete to $V = 20.5$, with a very sharp cut-off below this. These properties mean that corrections for completeness can be ignored in the following analysis, without introducing significant error.

3 SELECTION OF CLUSTER MEMBERS

Selection of candidate members of NGC 2547 proceeds largely as described in Naylor et al. (2002). Each star is tested against a number of criteria for membership. If a star does not fail any of these tests then it is retained as a candidate member. Briefly, these tests consist of investigating whether a star is: (a) close to the best fitting V vs $V - I_{\rm c}$ isochrone, defined in Naylor et al. (2002); (b) close to the V vs $B - V$ isochrone; (c) close to the $V - I_{\rm c}$ vs $B-V$ locus for cluster members. At the referee's request, we also attempted to use the UCAC1 proper motion catalogue (Zacharias et al. 2000) to refine our membership selection, but the data were not precise enough for our purposes.

In addition we apply a final test for possible binarity. If a star lies more than 0.3 mag. above the V vs $V - I_{\rm c}$ isochrone (or the V vs $B-V$ isochrone for stars with $V-I_{\rm c} < 0.5$) we class them as candidate unresolved binary systems. Naylor et al. (2002) calculate that this method is sensitive to binaries with mass ratio $q \geqslant 0.6$ for $V < 14$ and $q \geqslant 0.5$ for fainter cluster members.

For the brightest objects, for which we have no $V - I_{\rm c}$ colour, we were forced to use slightly different selection criteria. For these objects, membership was allocated to those stars which are close to the V vs $B-V$ isochrone. We reject those measurements which are affected by bad pixels, have poor sky subtraction, are flagged as non-stellar or which have uncertainties of greater than 0.2 mag. Above $V = 8$ the V vs $B-V$ isochrone lies nearly vertical and here members have been selected "by-eye". From the objects with no $V - I_{\rm c}$ colour, we selected a further 24 members, out of 39 objects.

For this paper we have introduced two further selection criteria. The membership selection for the very brightest stars was checked using the HIPPARCHOS proper motions (Baumgardt et al. 2000) and the radial velocities from the Revision of the General Catalogue of Radial Velocities (Evans 1967). In each case, our results for membership using the photometric cut described above agreed with the membership results using the proper motions and radial velocities. The only exception was the variable star KW Vel. Although this star was selected as a member on the basis of its photometric colours, Baumgardt et al. (2000) classified the object as a non-member on the basis of its proper motion. Hence, we removed KW Vel from our catalogue of members. As an aside, three objects (HIP # 40336, 40385 and 40427) were discovered in the HIPPARCHOS proper motions of Baumgardt et al. (2000) which lay well outside our surveyed region, but were selected as cluster members on the basis of their proper motions and HIPPARCHOS photometry. These stars lie about a degree away from the cluster centre, and we identify them as potential escaped cluster members.

We used the method described above to find 327 cluster candidates from the enhanced catalogue, of which 95 are probable unresolved, high mass ratio binaries. Figure 1 shows the V vs. $V-I_c$ colour-magnitude diagram, with cluster candidates indicated.

3.1 Field Star Contamination

We are confident that the membership selection criteria have included almost all the true cluster members. A crucial question regards the number of non-members which we have erroneously classed as members. We note that the NGC 2547 isochrone for PMS stars lies more than a magnitude above the ZAMS in the colour-magnitude diagram, and hence clear of background contamination. The exception is between $14.0 < V < 15.5$ (0.75–0.9$M_{\odot}$) where a "finger" of background giants intrudes onto the PMS locus. Here, in-

tegration of an interpolation of the density of stars above and below the cluster sequence suggests that the field star contamination could be as high as 40% in this region of colour-magnitude space.

The assumption that background contamination is negligible outside the contaminating finger has been tested by Jeffries et al. (2000), who performed high-resolution spectroscopy of 23 of the stars selected as cluster members by Naylor et al. (2002), with magnitudes in the range $12 < V < 15$. From the radial velocities there is good evidence that at least 20, and probably all, of these stars are indeed cluster members. Therefore, following Naylor et al. (2002), we assume contamination is negligible in the analysis which follows.

4 NGC 2547 AS A CLUSTER

4.1 The cluster centre

There are several ways to define a cluster centre; theoretically, it can be defined as the centre of mass, or the location of the deepest part of the gravitational potential, observationally the centre is often defined as the region of highest surface brightness, or the region containing the largest number of objects. Here we define the cluster centre as the being the location of maximum stellar density.

The cluster centre was found by fitting Gaussians to the profiles of star counts in right ascension and declination. These profiles are shown in figure 4. This method gives both a location for the cluster centre, and a formal error. Using this method, the cluster centre is found to be at $\alpha = 8.169^{+0.02}_{-0.01}$ hours and $\delta = -49.20^{+0.02}_{-0.02}$ degrees.

4.2 Is NGC 2547 bound?

We can determine an approximation to (strictly, a lower limit to) the half-mass radius of the cluster, by finding the radius which contains half the total mass in our survey. Unresolved binarity can be a problem for this technique if the binary fraction or distribution of mass ratios is a strong function of position within the cluster. Hence, we determined the half-mass radius by two methods; first by ignoring the problems raised by unresolved binary companions, and second using the scheme outlined in Naylor et al. (2002) to account for the high mass ratio binaries.

We find that the half mass radius of NGC 2547 is 10.7 arcmins, regardless of whether binaries are accounted for or not. We note here that the method used assumes spherical symmetry for the cluster. The effect of this assumption on the value of the half-mass radius was investigated by determining the half mass radius obtained for four quadrants of the cluster. The half mass radii found for these four quadrants ranged from 10 to 11 arcmins. Hence, we believe that the assumption of spherical symmetry does not introduce errors greater than 10%.

Using the half-mass radius as a lower limit to the total radius of the cluster, and the the velocity dispersion of Jeffries et al. (2000) of $\bar{v} \leqslant 1\,\mathrm{km\,s^{-1}}$, the virial mass is $M \simeq 2R_{tot}\bar{v}^2/G \approx 600M_{\odot}$. This value is highly uncertain, however, because the total radius of the cluster, and the velocity dispersion are basically unknown. The final result could easily vary by a factor of two either way. The total mass of NGC 2547 is $370M_{\odot}$, and therefore it is not possible to determine if NGC 2547 is bound with the data available at present. However, given its continued existence after 20–35 Myr, it seems likely that the cluster is at least close to being bound.

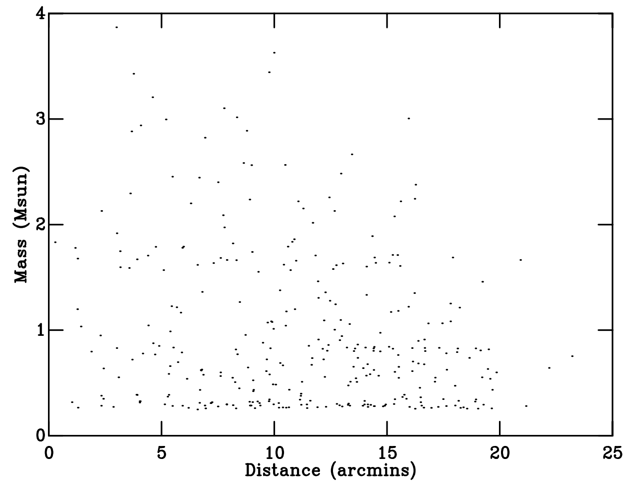

Figure 5. Mass segregation in NGC 2547

5 MASS SEGREGATION IN NGC 2547

The evidence for mass segregation in NGC 2547 can be seen from a plot of radius against mass for the cluster members (figure 5). Masses were allocated to stars following the procedure in Naylor et al. (2002), which makes corrections for binarity. The key features of this plot are: the "finger of contamination", see section 3.1, which is just visible as a strip of increased stellar density between 10 and 20 arcmins and $0.8 < M/M_{\odot} < 0.9$, and the sharp drop in the number of stars at around 18 arcmins. The mass segregation is visible as an absence of stars in th top-right of the diagram. In particular, the maximum radius seems to decrease above $2M_{\odot}$.

In an attempt to quantify the significance of this feature, we start from the null hypothesis that there is no mass segregation in NGC 2547. The approach used to test this hypothesis is described below.

- We use the radial distribution and mass function for NGC 2547 to create a model of the null hypothesis, in which there is no mass segregation (i.e. the radial distribution is independent of mass).
- The distribution of stars in NGC 2547 in the V-magnitude, radius plane is compared to that of the model, by measuring the D-statistic[1] from a two-dimensional, 1-sample K-S test.
- We now generate many fake clusters, which share the

[1] The D statistic is the largest difference between the fractions of data points which lie in the four quadrants around a point (x,y), and the corresponding fractions of data points from a model which corresponds to the null hypothesis, where the point (x, y) has been selected to maximise the D-statistic

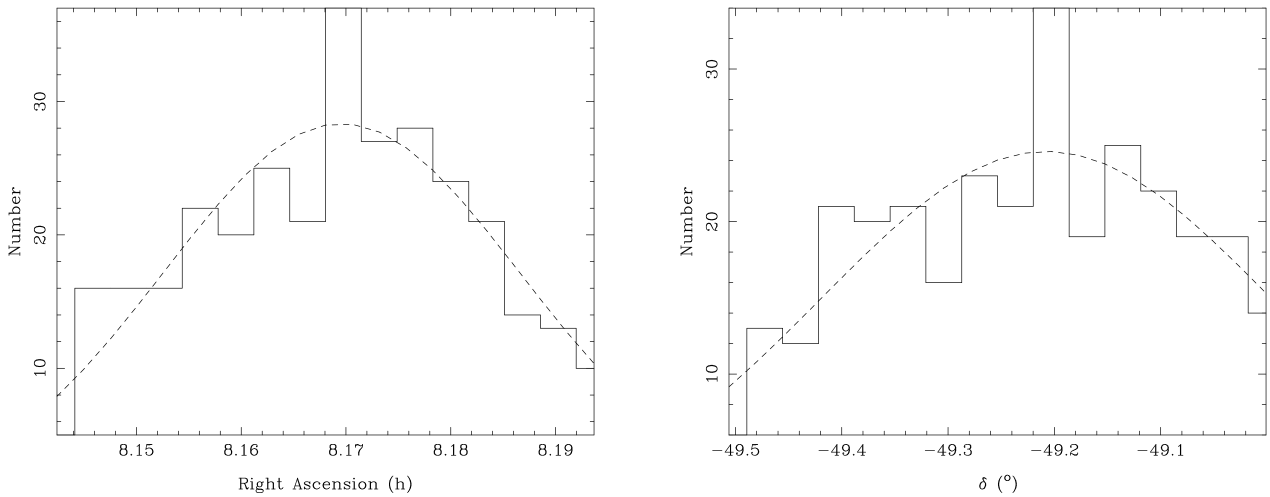

Figure 4. Profiles of stellar counts across NGC 2547. Only candidate members of NGC 2547 were included in the census. The Gaussian fits used to determine the cluster centre are shown as dashed lines.

mass function and radial distribution of NGC 2547, but show no mass segregation.

- We now perform the same K-S test applied previously to NGC 2547 to our fake clusters, in order to discover the distribution of the D-statistic in the null hypothesis.
- The D statistic from the real NGC 2547 data is compared to the distribution in the null hypothesis

The test described above gives a formal probability that there is **no** mass segregation in NGC2547 (mass function is independent of radius) of 95 per cent, in stark contrast to what we would expect from visually inspecting figure 5. Hence we see that the 2-d K-S test is not a powerful test for the presence of mass segregation. This lack of power arises because there are many possible deviations from the null hypothesis (independent mass and radius distributions) which do not correspond to the distributions expected from mass segregation. In testing the distribution of stars in NGC 2547 against all these possible deviations, we lose the sensitivity to detect the deviation we are interested in. We can see this is true if we formulate a different test, which only looks for deviations from the null hypothesis in the sense *expected* from mass segregation. In this test we generated 8000 fake clusters, of the same size as NGC 2547, which show no mass segregation. We then asked how many of these clusters showed a lack of high mass stars at large radii which was comparable with the data. Strictly, we determined the percentage of our clusters in which there was fewer than two stars whose radii in arcminutes obeyed $R \geqslant 30 - 5M$, where M is the stellar mass in solar units (NGC 2547 has only one such star). Only $\sim 2\%$ of our fake clusters met our criteria. What this test shows is that it is possible to gain sensitivity to the presence of mass segregation, by only testing for deviations in the sense expected. Hence, increased power comes at the cost of increased bias.

Having determined the presence of mass segregation in NGC 2547, it is pertinent to ask at what masses it is present. Figure 6 shows cumulative radial distributions for non-binary members of NGC 2547 in 3 mass bins. The "finger" of background giants (i.e. stars in the V magnitude range 14–15.5) has been excluded. A 1-D K-S test gives a 0.5 per cent probability that the $V < 9$ (approximating to

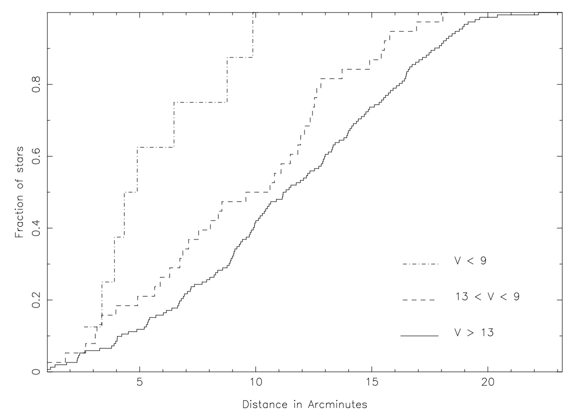

Figure 6. Cumulative fraction profiles of distance from cluster centre for stars of different mass in NGC 2547. The high mass stars ($V < 9$) are significantly centrally condensed. The distribution of intermediate mass stars ($9 < V < 13$, corresponding to $1 < M < 3\ M_{\odot}$) appear more centrally condensed than stars of low mass $V > 13$, but this is not formally significant (see text for details).

$M > 3\ M_{\odot}$) stars have the same radial distribution as the stars with $V > 9$, and a 3 per cent probability that the $V < 9$ stars have the same distribution as the stars with $9 < V < 13$. The results described above do not change if we move the cluster centre around 1σ in RA and Dec (i.e a 1.4 σ shift in centre position). In summary, the data show good evidence that the stars above $3M_{\odot}$ exhibit mass segregation.

A word of caution: the numbers above should not be regarded as representative of the formal significance, because we chose the mass bins as such because there were no stars with $V < 9$ outside the half mass radius (i.e. we have seen what we think is an effect in the data, and then set out to prove it is present). The K-S test assumes that the bin boundaries are chosen at random and will therefore have overestimated the significance of our results. The situation is somewhat analogous to the difficulties we found in applying the 2-d K-S test - the ability to detect mass segregation has come at the cost of some unknown level of bias. We

also note here that, to our knowledge, all previous studies of mass segregation have used a similar 1-d K-S test, and suffer from the same limitations.

If there is mass segregation above $3M_{\odot}$, and none in the lowest mass stars in our census, it is relevant to ask at what point mass segregation becomes important. This is revealed by the results of the 1-d KS test between the radial distributions of stars with $9 < V < 13$ and $V > 13$ ($V = 13$ is approximately $1M_{\odot}$). The 1-d K-S test gives a probability that these distributions are the same of 7 per cent. Although this result is not formally significant, it suggests that some mass segregation in NGC 2547 has occurred for stars with masses greater than somewhere between 1 and $3M_{\odot}$.

Hence we conclude that there is good evidence for mass segregation for the stars above $3M_{\odot}$. Weak evidence exists that mass segregation may have occurred down to $1M_{\odot}$ and there is no evidence that mass segregation has occurred for stars less massive than this.

5.1 Binary Stars

Several theoretical studies of mass segregation conclude that binary stars tend to be more centrally condensed than single stars because they are, on average, more massive. An early study by Abt (1980) found that this was indeed the case, but only for clusters older than 10^8 yr. Raboud & Mermilliod (1994) studied the distribution of red giant stars in 14 clusters with ages between 3×10^8 and 40×10^8 yr. They found that only M67 (the oldest cluster observed) showed a significant difference between the spatial distribution of red giant binaries and single red giants, confirming an earlier result by (Mathieu & Latham 1986). In contrast to these results, Raboud & Mermilliod (1998) find that the binary stars in the ~ 3 Myr old cluster NGC 6231 are centrally condensed.

In agreement with the findings of Abt (1980), there is no evidence that the binary stars in NGC 2547 are more centrally condensed than the single stars: the 1-d K-S test gives $P_{null} = 70$ per cent.

5.2 Timescales

The radial velocity dispersion in NGC 2547 is 1 $\mathrm{km\,s^{-1}}$ (Jeffries et al. 2000), though this is dominated by errors, and should be considered an upper limit. The total mass is 370 $M_{\odot}$ (Naylor et al. 2002), with 323 members down to a mass of 0.26 $M_{\odot}$ and out to radii of 20 arcmins (this paper).

With an age estimate for NGC 2547 of 20–35 Myr, this allows us to calculate a crossing time for the cluster of $\tau_{cr} \geqslant 3$ Myr. Bonnell & Davies (1998) show that mass segregation occurs for the higher mass stars in a cluster on the order of the relaxation time (see equation 1). For NGC 2547, this gives a relaxation time of $\tau_r \approx 20$ Myr, comparable with the age of the cluster.

Hence, NGC 2547 lies in an interesting region of parameter space where the cluster age is comparable to the time taken for mass segregation to appear. Because of this, detailed modelling is necessary to determine if the mass segregation observed in NGC 2547 is caused by dynamical evolution, or primordial effects.

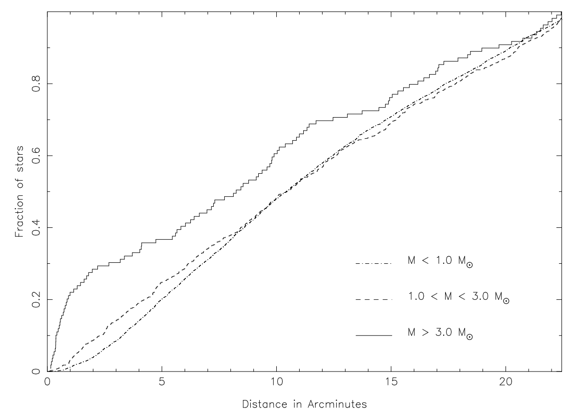

Figure 7. Average cumulative fraction profiles of distance from cluster centre for ten models of NGC 2547 at an age of 35 Myr. Some segregation of the high mass stars has begun, but mass segregation in our model is weaker than that observed in NGC 2547 itself.

5.3 Modelling

We modelled the dynamical evolution of NGC 2547 using the NBODY2 code. A model cluster was created by generating stars until the model cluster matched the total mass of NGC 2547. The probability of selecting a star of given mass and radius from cluster centre was weighted in order to match the observed mass function and half mass radius. The initial conditions in the model follow a Plummer distribution with an isothermal velocity distribution. The model contained no initial mass segregation.

Figure 7 shows the cumulative fraction profiles of distance from cluster centre for 10 models of NGC 2547 at 35 Myr with identical statistical properties but different initial random realisations. It can be seen that the high mass (M $> 3M_{\odot}$) stars are slightly centrally condensed, but that the low and medium mass stars show no mass segregation.

The model cluster shows less mass segregation at 35 Myr than observed in NGC 2547. This is most strongly seen in the high mass stars. In the model cluster 55% of the high mass stars lie outside the half-mass radius, whereas in NGC 2547 all of the high mass stars lie within this radius. If we assume that the high mass stars in NGC 2547 have the same radial distribution as seen in our model cluster, there is only a 0.2% chance of finding all eight high mass stars in NGC 2547 within the half mass radius. Hence dynamical evolution alone cannot explain the central concentration of high mass stars in NGC 2547 and we conclude that some, but not all of the mass segregation observed in NGC 2547 is primordial in origin.

6 CONCLUSIONS

We find evidence for the onset of mass segregation amongst the high mass ($> 3M_{\odot}$) members of NGC 2547. Weaker evidence exists for mass segregation down to $1M_{\odot}$. Modelling of NGC 2547 produces clusters with weaker mass segregation, implying a primordial origin for some of the mass segregation observed. Hence we conclude that, in some cases, primordial mass segregation can still be observed in intermediate (20–35 Myr) age clusters.

It is likely that NGC 2547 has suffered the loss of high mass stars through supernovae in its history. Supernovae are expected to have occurred at the age of NGC 2547 for stars more massive than roughly $8M_{\odot}$. Extrapolating the mass function of Naylor et al. (2002) we would expect to find around 2 stars more massive than this in NGC 2547, implying that at least one supernova has occurred in NGC 2547 in the past. It is therefore difficult to reconcile the mass segregation clearly observed in NGC 2547 with the suggestion by Raboud & Mermilliod (1998) that supernovae might remove traces of primordial mass segregation from a cluster.

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